

CLAIMS:

1. A sensor module for use with attenuated total internal reflection (ATIR) apparatus for optically determining the condition of a fluid, the sensor module comprising:
 - an evanescent wave sensor;
 - a module housing for said sensor; and
 - an optical connector for connecting said sensor to said ATIR apparatus.
2. A sensor module as claimed in claim 1 wherein said evanescent wave sensor comprises an optical fibre configured to allow interaction of an evanescent wave of light guided within the fibre with said fluid.
3. A sensor module as claimed in claim 2 wherein said fibre includes a tapered portion defining said evanescent wave sensor.
4. A sensor module as claimed in claim 2 or 3 wherein said optical connector comprises a portion of said optical fibre of said evanescent wave sensor.
5. A sensor module as claimed in claim 4 further comprising a mirror at a sensor end of said optical fibre.
6. A sensor module as claimed in claim 4 or 5 further comprising a mirror at a connector end of said optical fibre.
7. A sensor module as claimed in claim 6 or 7 wherein a said mirror comprises a coating on an end of said optical fibre.
8. A sensor module as claimed in any preceding claim wherein said module housing is fluid permeable.
9. A sensor module as claimed in claim 8 wherein said module housing comprises a ferrule for each end of said sensor and one or more spacers between said ferrules.
10. A sensor module as claimed in any preceding claim wherein said housing is fabricated from ceramic.
11. A dipstick incorporating the sensor module of any preceding claim.
12. Evanescent wave sensing or ATIR apparatus including the sensor module or dipstick of any preceding claim.
13. Apparatus for optically determining the condition of a fluid, the apparatus comprising:
 - a light source to provide light for interacting with said fluid;
 - a detector for detecting a level of light from said light source; and

an optical path between said light source and said detector, said optical path including a reflection from an evanescent wave interface; and

wherein said apparatus is configured such that said fluid may be brought sufficiently close to said interface for an evanescent wave formed by total internal reflection of light at said interface to interact with said fluid;

whereby a condition of said fluid is determinable from said detected light level.

14. Apparatus as claimed in claim 13 for attenuated total internal reflection (TIR) sensing, and wherein said evanescent wave interface comprises a substantially totally internally reflecting (TIR) interface.

15. Apparatus as claimed in claim 13 or 14 wherein said optical path further includes at least one mirror between said light source and said detector such that said optical path includes two reflections from said interface.

16. Apparatus as claimed in claim 15 wherein said optical path comprises a fibre optic, and wherein said interface comprises a tapered region of said fibre optic.

17. Apparatus as claimed in claim 15 or 16 wherein said fibre optic is provided with a protective housing.

18. Apparatus as claimed in claim 15 or 16 comprising a dipstick for sampling said fluid, said dipstick containing said fibre optic.

19. Apparatus as claimed in any of claims 15 to 18 wherein said fluid comprises a lubricant or has an absorbance of greater than 1, 2, 3, 4 or 5.

20. Apparatus as claimed in any one of claims 15 to 19 wherein said interaction between said evanescent wave and said fluid comprises absorption of light by said fluid.

21. Apparatus as claimed in any one of claims 15 to 20 wherein said interaction between said evanescent wave and said fluid includes coupling or propagation of light into said fluid.

22. Apparatus as claimed in any of claims 15 to 21 further comprising a signal processor coupled to said detector and configured to detect a change in said light level to detect a change in the condition of said fluid.

23. Apparatus as claimed in claim 22 wherein said signal processor is configured to detect a degradation in the condition of said fluid.

24. Apparatus as claimed in any one of claims 15 to 23 configured to provide and detect light at least two different wavelengths.

25. Apparatus as claimed in any one of claims 15 to 24 configured to determine a degree of light scatter by said fluid.

26. Apparatus as claimed in claim 25 when dependent upon claim 24 configured to compare detected light levels at said at least two different wavelengths to distinguish a change in detected light level caused by a change in temperature of said fluid from a change in detected light level caused by a change in light scatter of said fluid.

27. A method of optically determining the condition of a fluid using attenuated internal reflection, the method comprising:

measuring an attenuation of an internal reflection at an interface due to an interaction of light with said fluid mediated by an evanescent wave formed at said interface; and

determining a condition of said fluid from said attenuation.

28. A method as claimed in claim 27 wherein said fluid has an absorbance of greater than 1, 2, 3, 4 or 5.

29. A method as claimed in claim 27 or 28 wherein said fluid comprises a lubricant, more particularly oil.

30. A method as claimed in any one of claims 27 to 29 wherein said interaction comprises absorption of said light by said fluid.

31. A method as claimed in any one of claims 27 to 30 wherein said interaction includes coupling or propagation of said light to said fluid.

32. A method as claimed in any one of claims 27 to 31 comprising measuring said attenuation at two or more wavelengths to determine a degradation of said fluid.

33. A method as claimed in claim 32 comprising using said measured attenuation at two or more wavelengths for distinguishing between attenuation caused by a change in temperature from attenuation caused by a change in scatter.

34. A method as claimed in any one of claims 27 to 32 further comprising adjusting an extension of said evanescent wave from said interface into said fluid to adjust a degree of interaction between said evanescent wave and said fluid.

35. A method of determining a degree of degradation of a fluid, the method comprising measuring a level of particulate scattering by said fluid; and determining said degree of degradation of the fluid from said level of particulate scattering.

36. A method as claimed in claim 35 wherein said measuring comprises making a measurement responsive to a complex refractive index value of the fluid.

37. A method as claimed in claim 35 or 36 comprising measuring said level of particulate scattering using two or more wavelengths or colours to distinguish a change in particulate scattering from a temperature change.

38. Apparatus comprising means for implementing the method of claim 35, 36 or 37.

39. Optical fluid sensing apparatus, the apparatus comprising, an illumination source to source illumination at an operating wavelength of the apparatus, and a tapered fibre optic configured to couple light at said operating wavelength out of said taper and into said fluid, whereby a real or complex refractive index of said fluid may be determined.

40. An optical sensor module for use with evanescent field sensing apparatus for optically determining the condition of a fluid, the sensor module comprising:

- an evanescent wave sensor;
- a module housing for said sensor; and
- an optical connector for connecting said sensor to said evanescent field sensing apparatus.